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(54) **VENTURI JET STRUCTURE FOR FUEL DELIVERY MODULE OF A FUEL TANK**

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F02M 37/04 (2006.01)
F04F 5/00 (2006.01)

(52) **U.S. Cl.** **123/509**; 417/151

(58) **Field of Classification Search** 123/509, 123/514; 417/151

See application file for complete search history.

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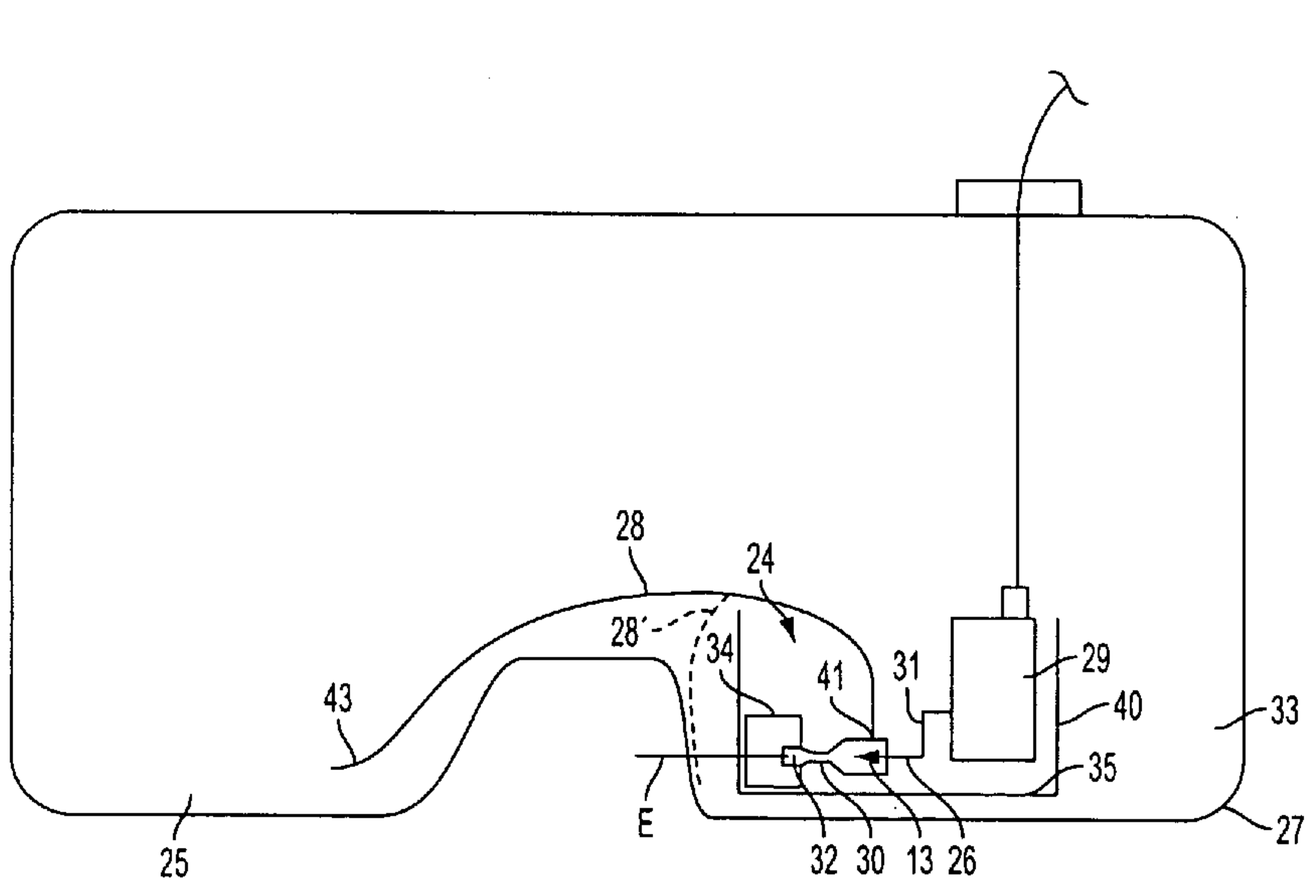
Primary Examiner — Thomas N Moulis

(57) **ABSTRACT**

A fuel delivery system includes a fuel tank having at least a main chamber. A reservoir is disposed in the main chamber. A fuel pump and venturi jet structure are provided in the reservoir. The venturi jet structure includes a jet inlet having a nozzle for receiving fuel from the fuel pump. A fuel inlet tube structure has a first end associated with the nozzle and a second end extending into a portion of the fuel tank. A mixing tube is in communication with, and downstream of, the jet inlet and the fuel inlet tube structure. An outlet is in communication with, and downstream of, the mixing tube. A length of the fuel inlet tube structure is greater than a length of the outlet, and the mixing tube is mounted so that an axis thereof is generally horizontal ±39.90 degrees with respect to the bottom surface of the reservoir.

20 Claims, 2 Drawing Sheets



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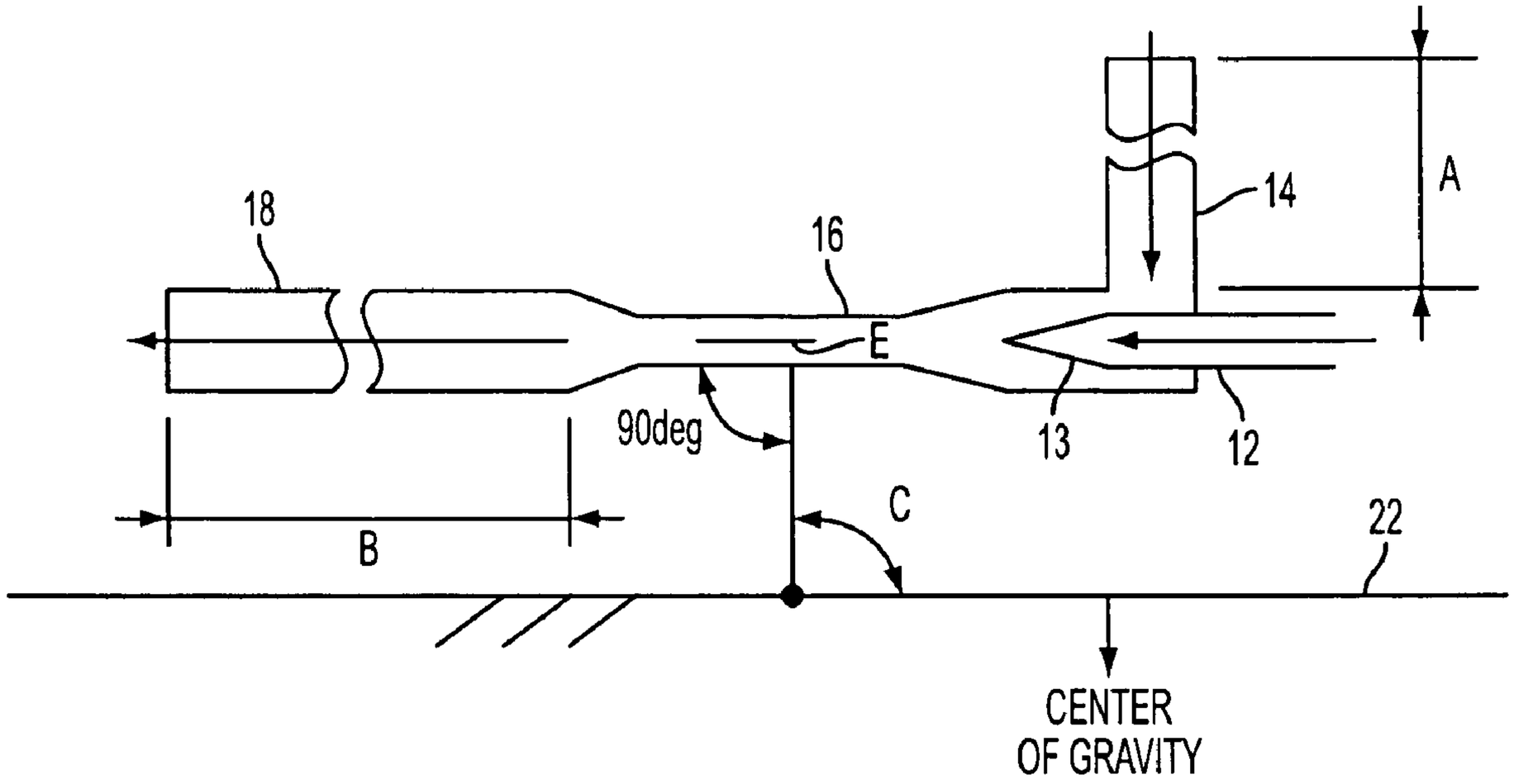

FIG. 1
PRIOR ART

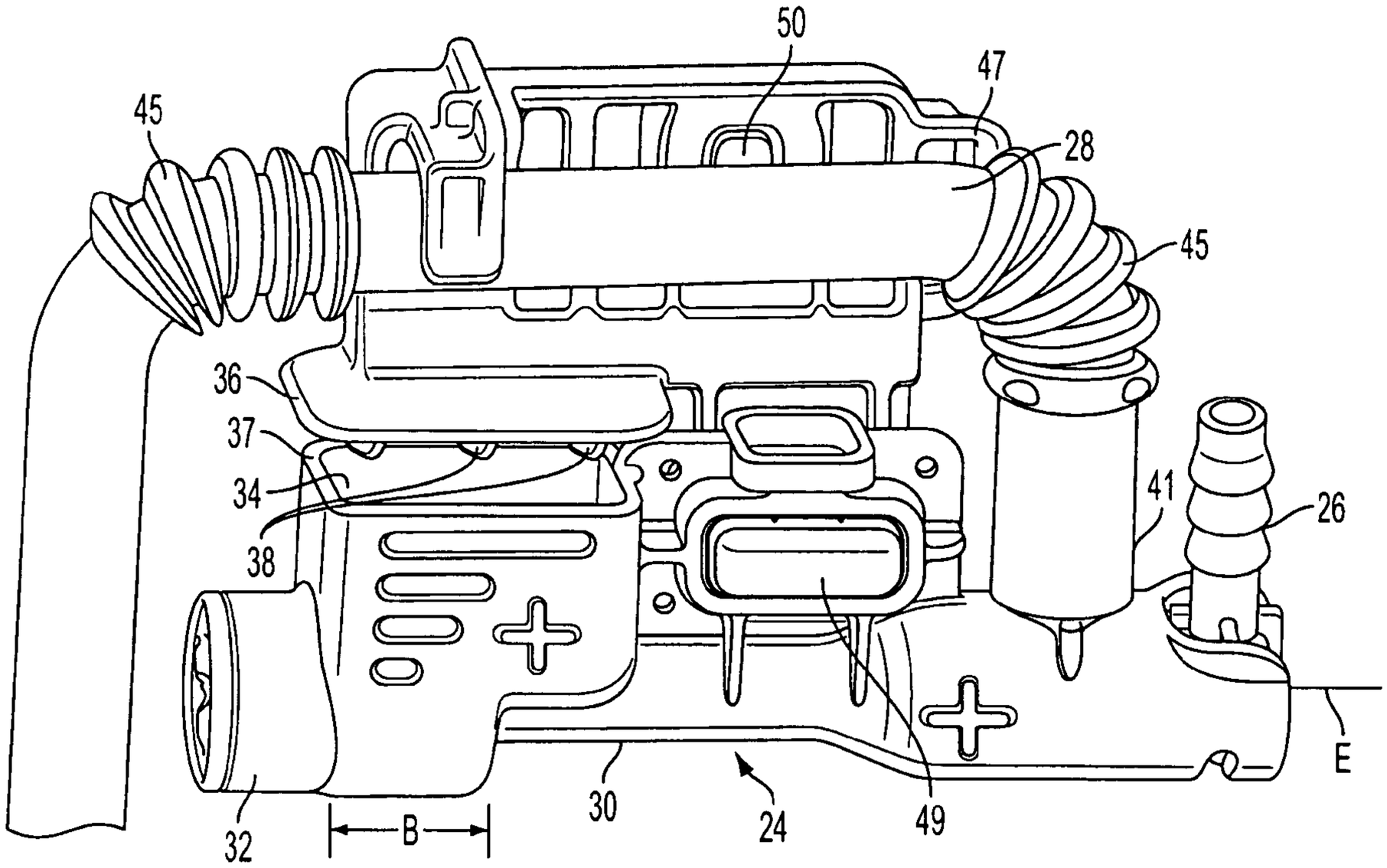
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FIG. 2

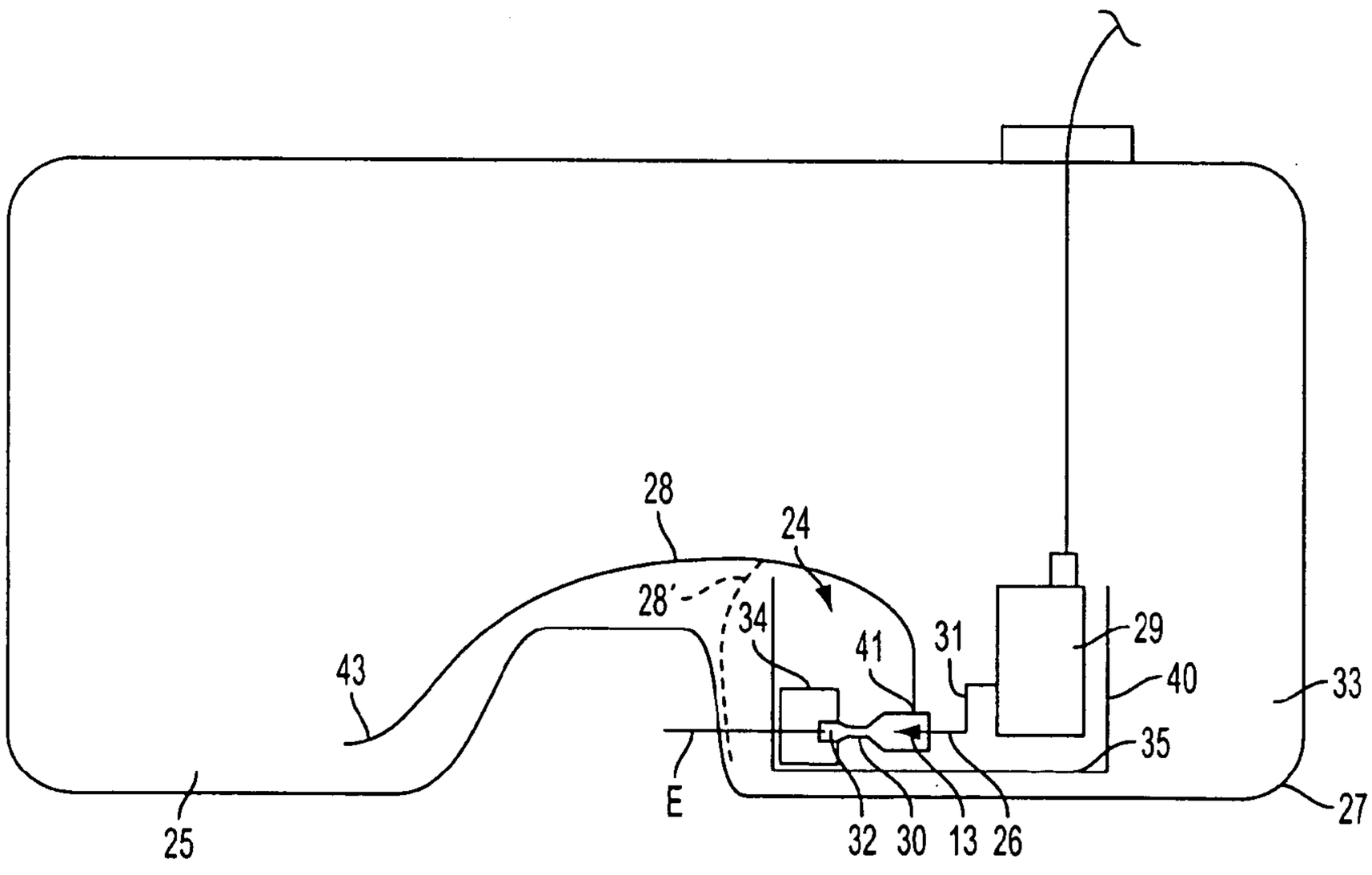
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FIG. 3

VENTURI JET STRUCTURE FOR FUEL DELIVERY MODULE OF A FUEL TANK

This application claims the benefit of the earlier filing date of U.S. Provisional Application No. 60/936,404, filed on Jun. 18, 2007, which is hereby incorporated by reference into this specification.

FIELD OF THE INVENTION

The invention relates to fuel delivery modules for automobile vehicles and, more particularly, to a venturi jet structure that can operate within a wide range of mounting orientations.

BACKGROUND OF THE INVENTION

A venturi jet of a fuel delivery module is used to draw fuel from a fuel tank into a separate reservoir inside of the fuel tank. A fuel pump delivers fuel from the reservoir to the engine of a vehicle. An example of the use of a venturi tube in a fuel delivery module using a single chamber fuel tank is disclosed in U.S. Pat. No. 6,951,208, the content of which is hereby incorporated by reference into this specification.

With reference to FIG. **1**, a conventional venturi jet structure is shown generally indicated at **10** that is employed in a single chamber fuel tank. The structure **10** includes a jet inlet **12** having a nozzle **13**. The inlet **12** receives fuel from a pump (not shown) and as the fuel flow through the nozzle; a vacuum is created to draw fuel into inlet **14**. The inlets **12** and **14** are disposed upstream of a reduced diameter mixing tube **16**. The mixing tube **16** is connected with an outlet **18**. A fuel tank bottom is indicated at **22**. Table 1 below shows the different mounting options for the venturi jet structure **10** of FIG. **1**. These five options require significant vertical packaging space.

TABLE 1

Options	Inlet to Outlet Ratio	Typical Angle C
1	A < B	+90 deg or −90 deg
2	A = B	+90 deg or −90 deg
3	A < B	0 deg or 180 deg
4	A > B	0 deg or 180 deg
5	A = B	0 deg or 180 deg

In Table 1, the angle C of 90 degrees (plus or minus) indicates that the venturi jet structure **10** is horizontally disposed with respect to the axis E of the mixing tube **16** (e.g., parallel to the bottom **22** of the tank).

In dual chamber fuel tank applications, only one side of the tank (main side) is equipped with a fuel pump. The second side of the tank contains usually only the level sensor unit. Since there will be fuel in the second side of the dual chamber fuel tank, it has to be pumped over to the main side. There are currently two concepts known to do this: 1), a venturi jet same as option no. 1 or 3 above (e.g., the jet is physically located on the second side, driven by a return flow coming into the second side or by a flow from the main side), or 2), a venturi jet same as option no. 2 or 4 or 5 (e.g., the jet is physically located on the main side). The second concept is preferred due to cost, since there is no need for two tubes from the main side to the second side and this allows for tighter integration into the main fuel module.

There is a need provide a venturi jet structure that can be mounted within a wide range of orientations on a main side of a fuel tank and that reduces packaging space and cost.

SUMMARY OF THE INVENTION

An object of the disclosed embodiments is to fulfill the need referred to above. In accordance with the principles of a disclosed embodiment, this objective is obtained by providing a fuel delivery system including a fuel tank having at least a main chamber. A reservoir, having a bottom, is disposed in the main chamber.

A fuel pump and venturi jet structure are provided in the reservoir. The venturi jet structure includes a jet inlet constructed and arranged to receive fuel from the fuel pump. The jet inlet includes a nozzle. A fuel inlet tube structure has a first end associated with the nozzle and a second end extending into a portion of the fuel tank. A mixing tube is in communication with, and downstream of, the jet inlet and the fuel inlet tube structure. An outlet is in communication with, and downstream of, the mixing tube. The venturi jet structure is constructed and arranged such that when fuel is passed through the nozzle, a vacuum is created to draw fuel from the portion of the fuel tank via the fuel inlet tube structure, through the mixing tube, and out of the outlet. A length of the fuel inlet tube structure is greater than a length of the outlet, and the mixing tube is mounted so that an axis thereof is generally horizontal ±39.90 degrees with respect to the bottom surface of the reservoir.

In accordance with another aspect of a disclosed embodiment, a fuel delivery system includes a fuel tank having at least a main chamber. A reservoir, having a bottom, is disposed in the main chamber. A fuel pump and means for drawing fuel are disposed in the reservoir. The means for drawing fuel includes an inlet constructed and arranged to receive fuel from the fuel pump. The inlet includes means for creating a vacuum. A fuel inlet tube structure has a first end associated with the means for creating a vacuum and a second end extending into a portion of the fuel tank. A mixing tube is in communication with, and downstream of, the inlet and the fuel inlet tube structure. An outlet is in communication with, and downstream of, the mixing tube. The means for drawing fuel is constructed and arranged such that when fuel is passed through the means for creating a vacuum, a vacuum is created to draw fuel from the portion of the fuel tank via the fuel inlet tube, through the mixing tube, and out of the outlet. A length of the fuel inlet tube structure is greater than a length of the outlet, and the mixing tube is mounted so that an axis thereof is generally horizontal ±39.90 degrees with respect to the bottom surface of the reservoir.

Other objects, features and characteristics of the present invention, as well as the methods of operation and the functions of the related elements of the structure, the combination of parts and economics of manufacture will become more apparent upon consideration of the following detailed description and appended claims with reference to the accompanying drawings, all of which form a part of this specification.

BRIEF DESCRIPTION OF THE DRAWINGS

The disclosed embodiments will be better understood from the following detailed description of the preferred embodiments thereof, taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts, in which:

FIG. **1** is a view of a conventional venturi jet structure for a fuel delivery module of a vehicle used in a single chamber fuel tank.

FIG. **2** is a front view of a venturi jet structure provided in accordance with the principles of a disclosed embodiment.

FIG. **3** is a schematic view of a fuel delivery system including the venturi jet structure of FIG. **2** and a fuel pump in a main chamber of a dual chamber fuel tank.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENT

For a given performance of a venturi jet, the jet has a given total length. This length does not change with the orientation (e.g. horizontally or vertically oriented or anything in-between). A more powerful and/or more efficient jet typically requires a longer length. Most dual chamber fuel tanks have a rather shallow design, making it difficult to package a fuel delivery module into it. A vertically oriented jet takes away directly from the available height the fuel module has to be packaged in, limiting the design and performance of the fuel delivery module. A more powerful jet is needed for cars with high engine output. A more efficient jet is needed for reducing the jet (inlet) flow. The flow comes from the fuel pump in addition to required engine fuel consumption, so less jet flow means a less powerful pump is needed. This decreases cost and current draw of the pump (enables higher miles per gallon for the vehicle).

With reference to FIG. **2** a front view of a venturi jet structure is shown, generally indicated at **24**, in accordance with a disclosed embodiment. The venturi jet structure **24** is able to be packaged generally horizontally (or within the angle range C in Table 2 below) and therefore provides an advantage in regard to cost and performance of a fuel delivery module. Thus, the embodiment of FIGS. **2** and **3** defines an option **6** as indicated in Table 2, with the parameters defined in FIG. **1**).

TABLE 2

Option	Inlet to Outlet Ratio	Typical Angle C
6	A > B	+50.10 deg to 129.90 deg

With reference to FIGS. **2** and **3**, the venturi jet structure **24** includes a jet inlet **26**, including a nozzle **13**, which is fed fuel from fuel pump **29** via line **31**. A vacuum is created by fuel flowing through the nozzle **13** to draw fuel into an inlet tube structure **28**, having an end **41** that is associated with the nozzle **13**. The other end **43** of the inlet tube structure **28** extends into the secondary chamber **25** of a dual chamber fuel tank **27**. The inlet tube structure **28** includes corrugated, flexible portions **45** such that portions of the inlet tube structure **28** can be bent to orient the inlet tube structure **28** within the fuel tank **27** as desired. Both the inlet **26** and inlet tube structure **28** are upstream of a mixing tube **30**. The mixing tube **30** is connected with a preferably tubular outlet **32** and has a diameter less than a diameter of each of the fuel inlet tube structure **28** and outlet **32**.

With reference to FIG. **3**, and Table 2, the longitudinal axis E of the mixing tube **30** of the venturi jet structure **24** is disposed generally horizontally (horizontal, C=90 deg)±39.90 degrees. In other words, when horizontally disposed, the axis E of the mixing tube **30** is parallel with the bottom surface **35**. The venturi jet structure **24** and fuel pump **29** are disposed in the reservoir **40** in a main chamber **33** of the dual chamber fuel tank **27**. The dimension A in Table 2 is the length of the inlet tube structure **28**. The dimension B is shown in FIG. **2** and is the length of the outlet **32**. The length A of the fuel inlet tube structure **28** is greater than the length B of the outlet **32**.

With reference to FIG. **3**, the inlet tube structure **28** can include a tube portion **28'** that is disposed in the main chamber **33** of the fuel tank **27** for drawing fuel from the main chamber **28**. The length of the tube proton **28'** (e.g., dimension A in Table 2) is greater than the length B of the outlet **32**. Thus, if the inlet tube structure **28** includes only the tube portion **28'**, the venturi jet structure **24** can be used in a fuel tank having only a main chamber **33**.

In the illustrated embodiment, an optional bucket **34** is provided to keep the mixing tube **30** filled with fuel. In the embodiment, the bucket **34** is made integral with the outlet **32**. Thus, fuel is expelled generally horizontally into the bucket **34** and the bucket fills vertically with fuel. This fuel will reduce the time it takes to "start" the venturi jet structure **24** (in order to create a vacuum the system has to be hydraulically "sealed"). A deflector **36** is preferably provided over an opened end **37** of the bucket **34**, and spaced therefrom. The deflector **36** is preferably part of a bracket **45** that holds a portion of the inlet tube **28**. The bracket **47** is coupled to the venturi jet structure **24** at connection **49**. The bracket **47** includes clip structure **50** constructed and arranged to couple the bracket **47** to the reservoir **40** thereby mounting the venturi jet structure **24** within the reservoir **40**. The underside of the deflector **36** facing the open end **37** of the bucket **34** preferably includes baffles or ribs **38** such that the deflector **36** prevents uncontrolled vertical fuel to spray out of the bucket **34**. Such uncontrolled fuel spray causes vapor generation, noise and reduces the amount of fuel being filled into the reservoir (as it could splash outside of it). Thus, the deflector **36** is constructed and arranged to deflect the spray of fuel from the vertical direction.

When the fuel pump operates, fuel from the pump **29** is sent through the nozzle **13** creating a vacuum to draw fuel from the secondary chamber **25** and/or the main chamber **33** of the fuel tank **27** via inlet tube structure **28** into the mixing chamber **30**. Fuel then exits the outlet **32** and cup **34** and dumps into the reservoir **40** to keep fuel in the reservoir to be pumped to the engine by the fuel pump **29**. Since the venturi jet structure **24** is disposed in the main chamber **33**, only one tube (e.g., main poring of the tube structure **28**) is needed to extend into the secondary chamber **25**. Further, since the mixing tube **30** is disposed generally horizontally within the reservoir **40**, it reduces vertical packaging space and cost.

The foregoing preferred embodiments have been shown and described for the purposes of illustrating the structural and functional principles of the present embodiments, as well as illustrating the methods of employing the preferred embodiments and are subject to change without departing from such principles. Therefore, the embodiments include all modifications encompassed within the spirit of the following claims.

What is claimed is:

1. A fuel delivery system comprising:

a fuel tank having at least a main chamber,

a reservoir having a bottom, the reservoir being separate from the fuel tank and disposed in the main chamber,

a fuel pump in the reservoir, and

a venturi jet structure disposed in the reservoir, the venturi jet structure comprising:

a jet inlet constructed and arranged to receive fuel directly from the fuel pump, the jet inlet including a nozzle,

a fuel inlet tube structure having a first end associated with the nozzle and a second end extending into a portion of the fuel tank,

a mixing tube in communication with, and downstream of, the jet inlet and the fuel inlet tube structure, and

an outlet in communication with, and downstream of, the mixing tube,

wherein the venturi jet structure is constructed and arranged such that when fuel is passed through the nozzle, a vacuum is created to draw fuel from the fuel tank portion via the fuel inlet tube structure, through the mixing tube, and out of the outlet, and

wherein a length of the fuel inlet tube structure is greater than a length of the outlet, and the mixing tube is mounted so that an axis thereof is generally horizontal and thus generally parallel with respect to the bottom surface of the reservoir.

2. The system of claim **1**, wherein the portion of the fuel tank is the main chamber.

3. The system of claim **1**, wherein the fuel tank further includes a secondary chamber, the fuel inlet tube structure including a portion that extends into the secondary chamber and another portion that is disposed in the main chamber so fuel can be drawn from the secondary chamber and the main chamber.

4. The system of claim **1**, wherein the outlet is a tubular member and the mixing tube has a diameter less than a diameter of each of the fuel inlet tube structure and the outlet.

5. The system of claim **1**, further including a bucket associated with the outlet such that when fuel exits the outlet, it is expelled generally horizontally into the bucket, with the bucket filling vertically with fuel.

6. The system of claim **5**, wherein in the bucket is made integral with the outlet.

7. The system of claim **5**, further including a deflector provided over an opened end of the bucket and spaced therefrom constructed and arranged to deflect fuel that is vertically expelled from the bucket.

8. The system of claim **7**, wherein an underside of the deflector facing the opened end of the bucket includes ribs.

9. The system of claim **7**, wherein the deflector is part of a bracket that holds a portion of the fuel inlet tube structure.

10. The system of claim **1**, further comprising a bracket coupled to the venturi jet structure, the bracket including clip structure to couple the bracket to the reservoir.

11. A fuel delivery system comprising:

a fuel tank having at least a main chamber,

a reservoir having a bottom, the reservoir being separate from the fuel tank and disposed in the main chamber,

a fuel pump in the reservoir, and

means for drawing fuel disposed in the reservoir, the means for drawing fuel comprising:

an inlet constructed and arranged to receive fuel directly from the fuel pump, the inlet including means for creating a vacuum,

a fuel inlet tube structure having a first end associated with the means for creating a vacuum and a second end extending into a portion of the fuel tank,

a mixing tube in communication with, and downstream of, the inlet and the fuel inlet tube structure, and

an outlet in communication with, and downstream of, the mixing tube,

wherein the means for drawing fuel is constructed and arranged such that when fuel is passed through the means for creating a vacuum, a vacuum is created to draw fuel from the portion of the fuel tank via the fuel inlet tube structure, through the mixing tube, and out of the outlet, and

wherein a length of the fuel inlet tube structure is greater than a length of the outlet, and the mixing tube is mounted so that an axis thereof is generally horizontal and thus generally parallel with respect to the bottom surface of the reservoir.

12. The system of claim **11**, wherein the portion of the fuel tank is the main chamber.

13. The system of claim **11**, wherein the fuel tank further includes a secondary chamber, the fuel inlet tube structure including a portion that extends into the secondary chamber and another portion that is disposed in the main chamber so fuel can be drawn from the secondary chamber and the main chamber.

14. The system of claim **11**, wherein the outlet is a tubular member and the mixing tube has a diameter less than a diameter of each of the fuel inlet tube structure and the outlet.

15. The system of claim **11**, further including a bucket associated with the outlet such that when fuel exits the outlet, it is expelled generally horizontally into the bucket, with the bucket filling vertically with fuel.

16. The system of claim **15**, wherein in the bucket is made integral with the outlet.

17. The system of claim **15**, further including a deflector provided over an opened end of the bucket and spaced therefrom constructed and arranged to deflect fuel that is vertically expelled from the bucket.

18. The system of claim **17**, wherein an underside of the deflector facing the opened end of the bucket includes ribs.

19. The system of claim **17**, wherein the deflector is part of a bracket that holds a portion of the fuel inlet tube structure.

20. The system of claim **11**, further comprising a bracket coupled to the venturi jet structure, the bracket including clip structure to couple the bracket to the reservoir.

* * * * *